

Dynamic species modeling; Predicting CA vegetation niches under climate change

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The PIER Ecosystem Modeling Project

- assess climate change impacts on CA biodiversity,
- estimate changes in potential and realized niches for *individual species* under climate change scenarios.



Importance of species-level analysis

- Previous research

 - Species distribution modeling

 - (e.g. Heikkinen et al. 2006; Pearson and Dawson, 2003; Thuiller 2003)

- Community assemblages may disassociate

 - Changes in individual species' dispersal, germination, survival rates.
 - How do species behave individually in the context of competition, dispersal limitations and disturbance?

Species Distribution Modeling (Thuiller et al. 2003)

- Building and validating individual species models
- Reducing uncertainty of models
- Predicting potential niches



Species Distribution Model Methods

Selecting species & environmental data



GLM/GAM/GBM/CART/ANN

Bayesian Approach

Building & validating models

Species Distribution Model Methods

Climate data

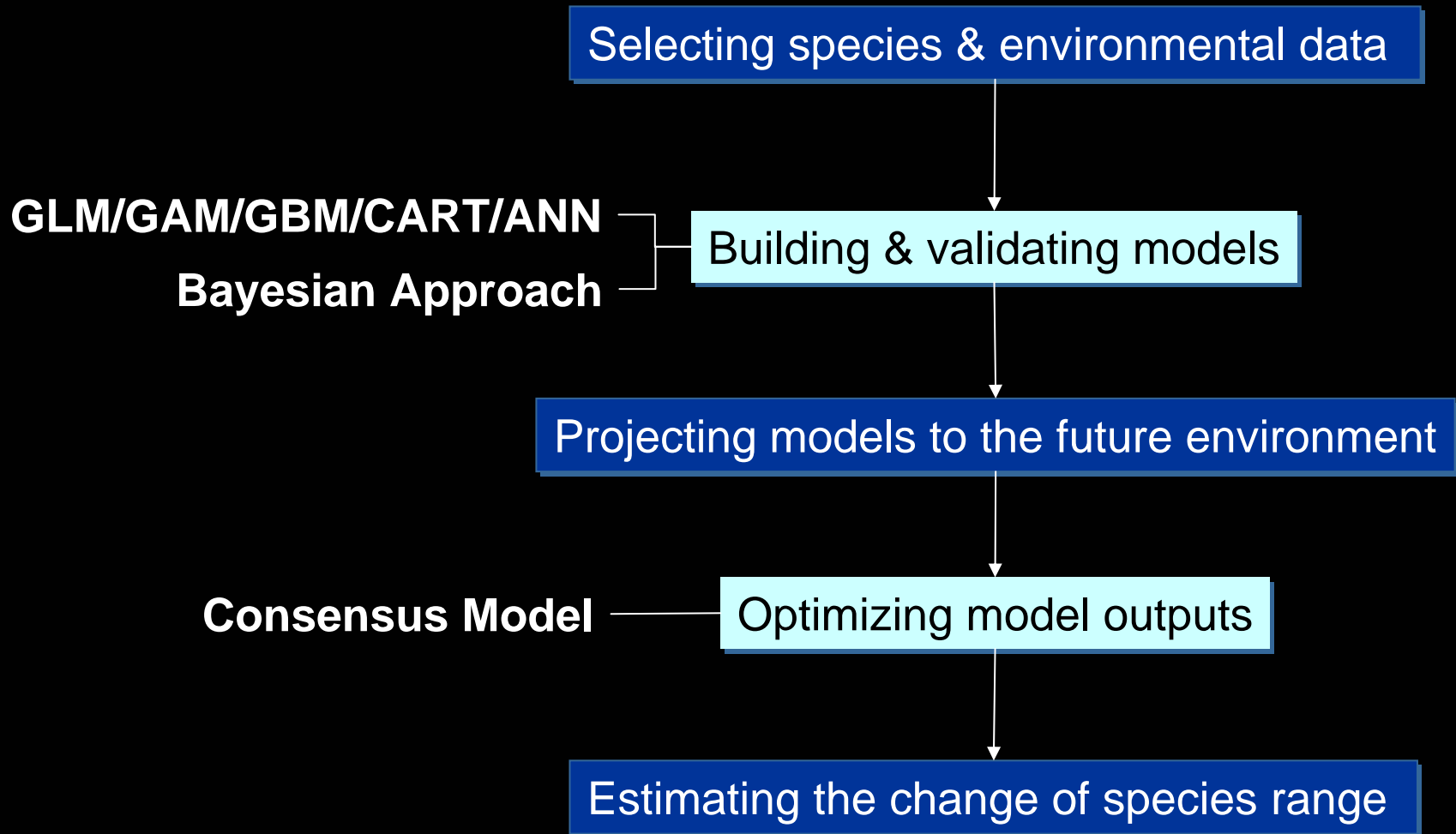
Max Temp of Warmest Month
Min Temp of Coldest Month
Annual Temp Range
Mean Temp of Wettest Quarter
Mean Temp of Driest Quarter
Precipitation of Wettest Quarter
Precipitation of Driest Quarter

+

Soil data

Available Water Capacity
Soil depth
Soil pH
Salinity
Depth of water table

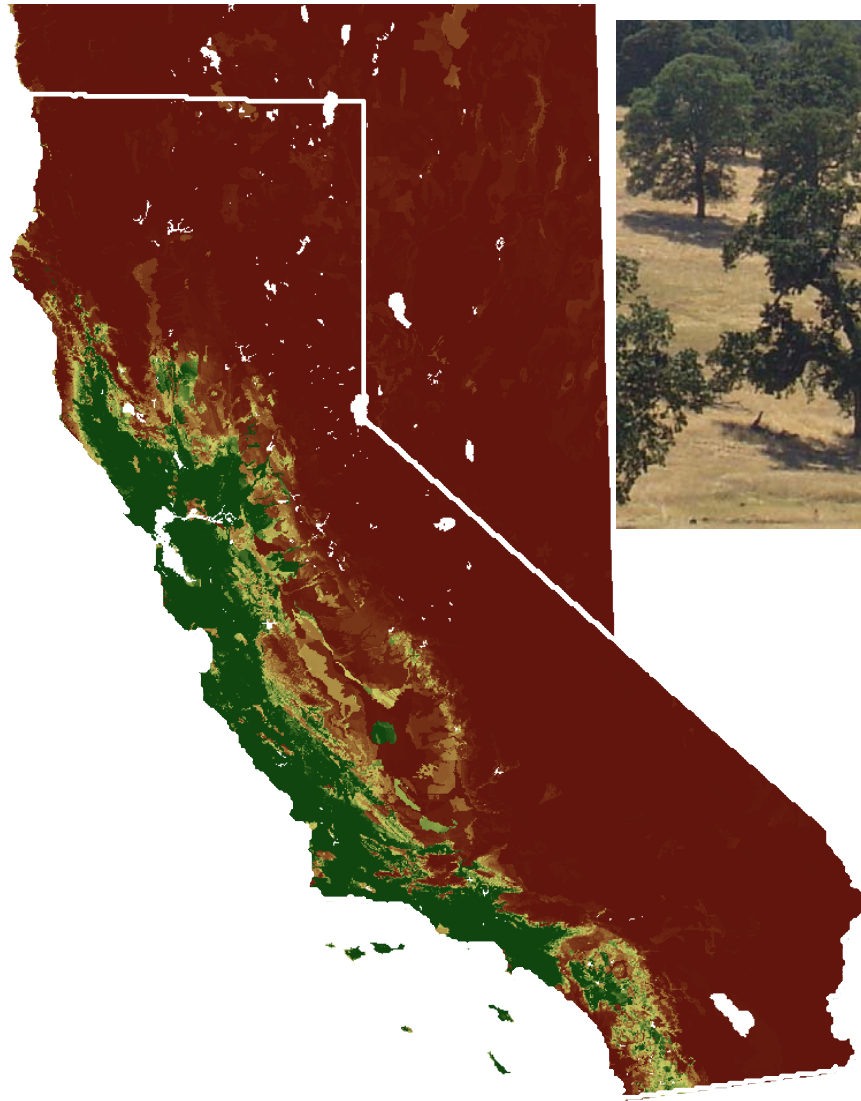
Species Distribution Model Methods





Quercus agrifolia
Hadley A2 Scenario

Present



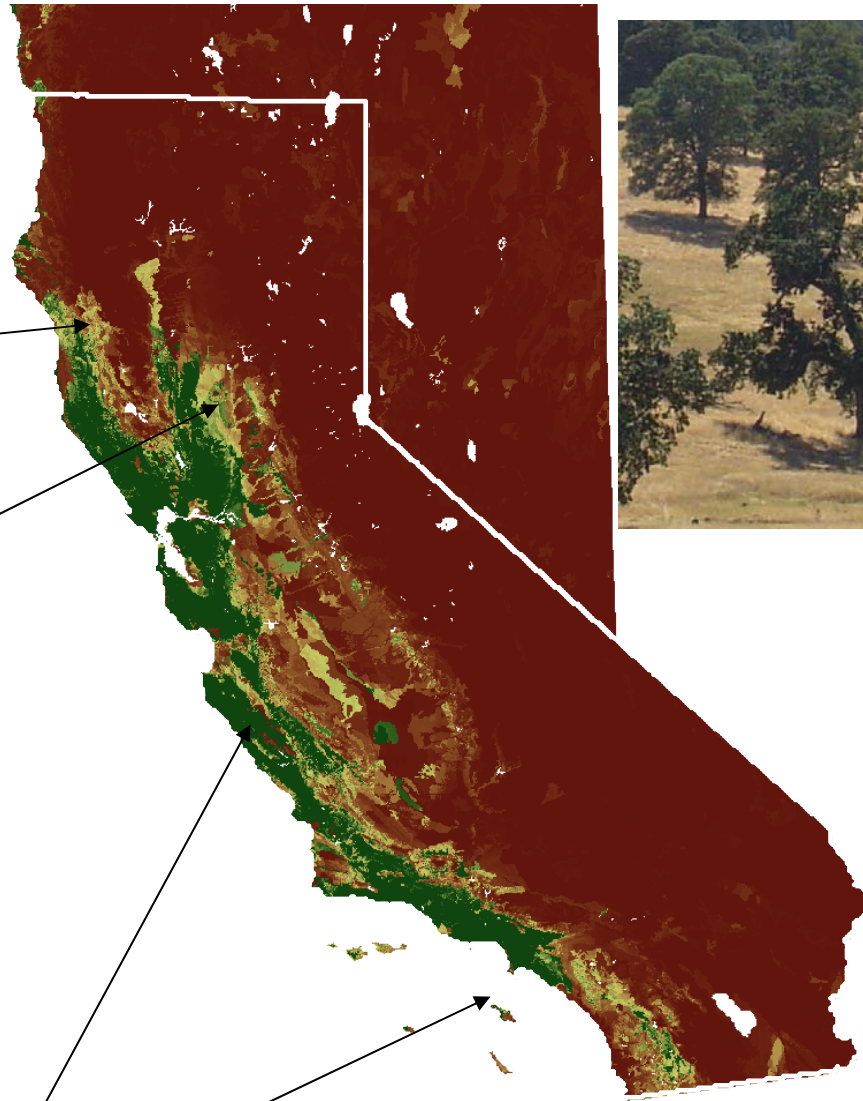
Quercus agrifolia
Hadley A2 Scenario

2080

shift

gain

loss



Species Distribution Model Output To Date:

314 Species { Mojave
Mixed conifer
Coastal sage scrub

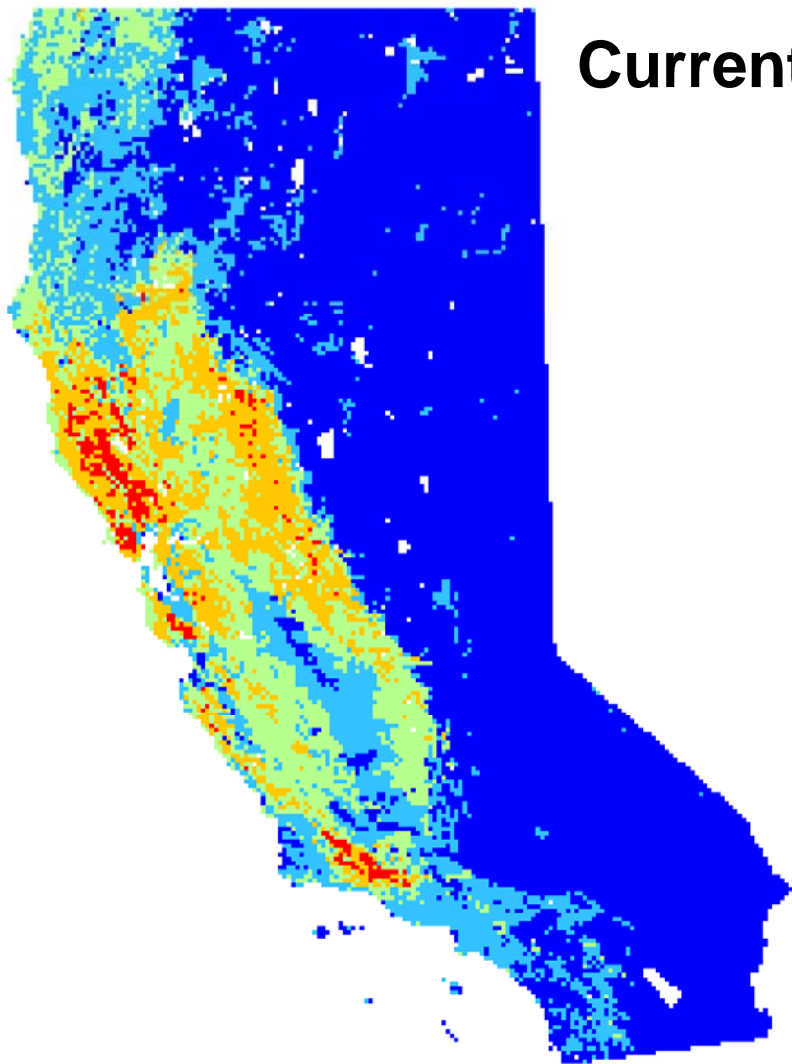
89 California
Endemic

13 *Pinus* spp.
15 *Quercus* spp.
13 *Ceanothus* spp.
9 *Arctostaphylos* spp.

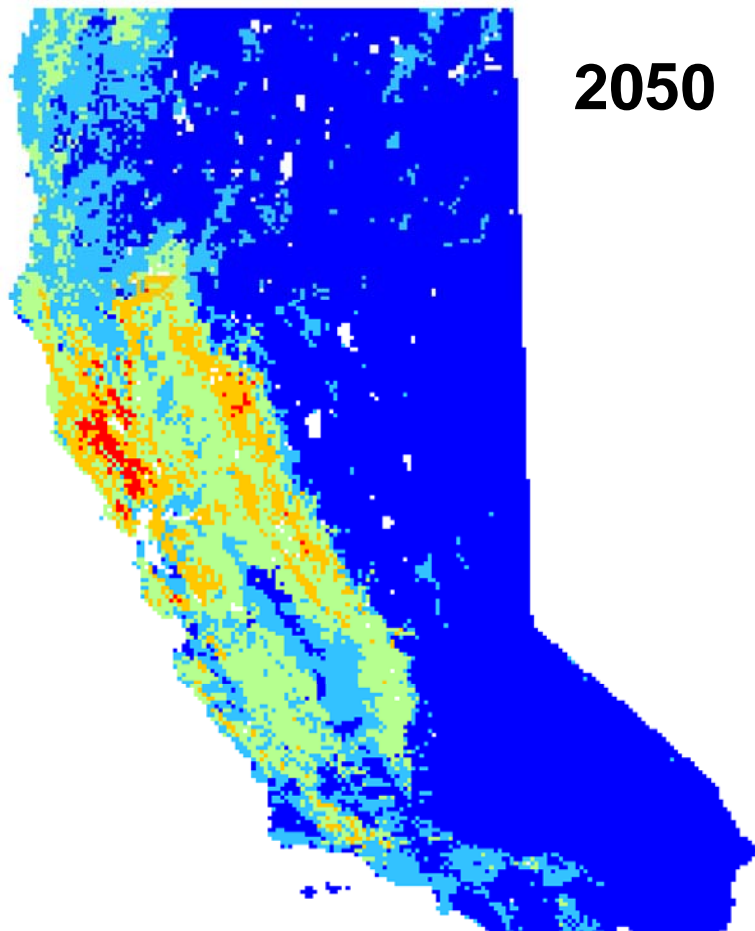


Endemic Richness

Current



2050



What about...

Dispersal?

Short and long distance
events

Competition?

Plant functional type-age and
size classes, fecundity,
mortality, germination

Disturbance?

Fire, grazing



BioMove; a dynamic modeling approach

A spatially explicit model used to predict the movement of individual species

Simulates dispersal, competition and disturbance

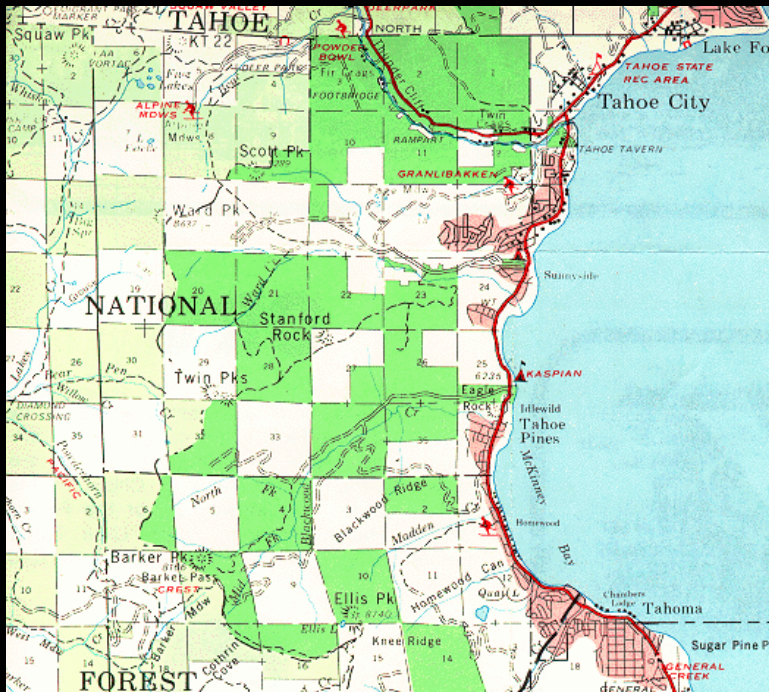
Can be used to predict movement of species

- applied management
- assess species change under various GHG stabilization trajectories

BioMove; A Case Study

Pinus lambertiana

“This is the noblest pine yet discovered, surpassing all others not merely in size but also in kingly beauty and majesty.”
(John Muir, 1894)



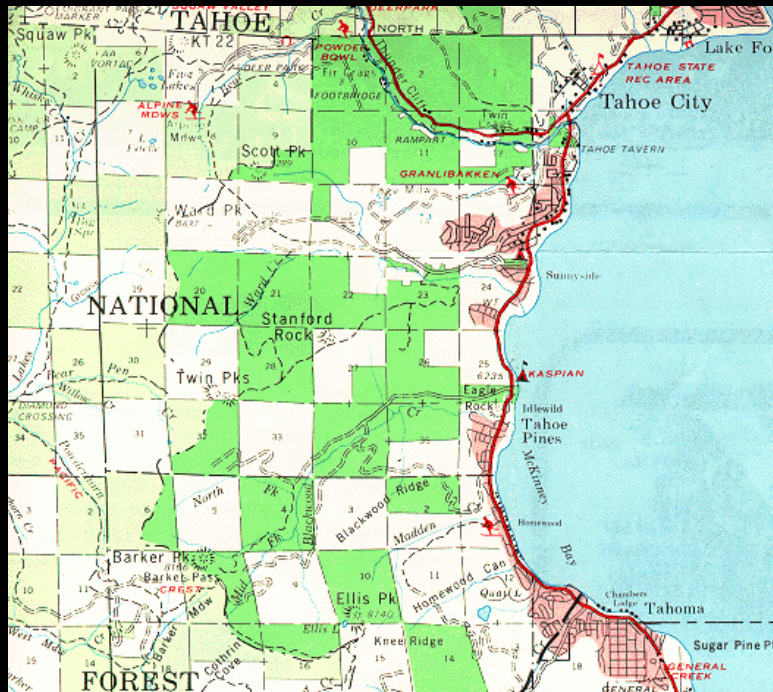
<http://www.lib.berkeley.edu/EART/tour/TahoeNationalForest.gif>



BioMove; A Case Study

Pinus lambertiana

“This is the noblest pine yet discovered, surpassing all others not merely in size but also in kingly beauty and majesty. “
(John Muir, 1894)



What is the fate of this species in the “checkerboard” region?

DLGBiomoveII

Life history and seedpools | Resource response | Morphology | **Biomove**

Demography | Competition | Disturbance | Envelopes | Dispersal

Age class limits

Seeding <= 2

Immature <= 7

Mature <= 25

Senescent <= 30

% death during age class

Seedlings 70

Immature 30

Mature 30

Senescent 95

Max cell population: 100000

<- These death rates are the death rate for the entire age class. E.g. if maturity is at 20 and senescence at 100 then mature age class is 80 years. The mature death rate is the % that die over 80 years.

Effective propagules

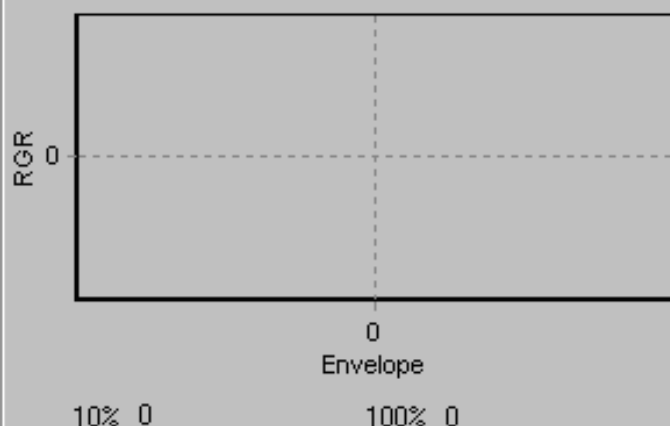
Mature 5 Senescent 2

Seed pool life span

Active 2 Dormant 50

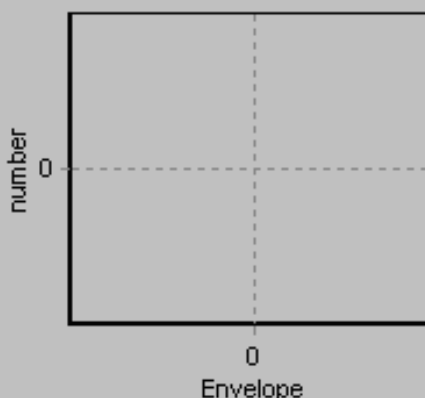
Relative growth rate

RGR at 10 envelope values



☐ Fixed scale

Age classes



- ☒ Pool
- ☒ Sdlg
- ☒ Juv
- ☒ Mat
- ☒ Sen

Calculate RGR

☒ Density dependent recruitment

☒ Thinning

☒ Productivity dependent survival

☐ Show point model

☐ Calculate intra-lifecycle abundances

OK

Cancel

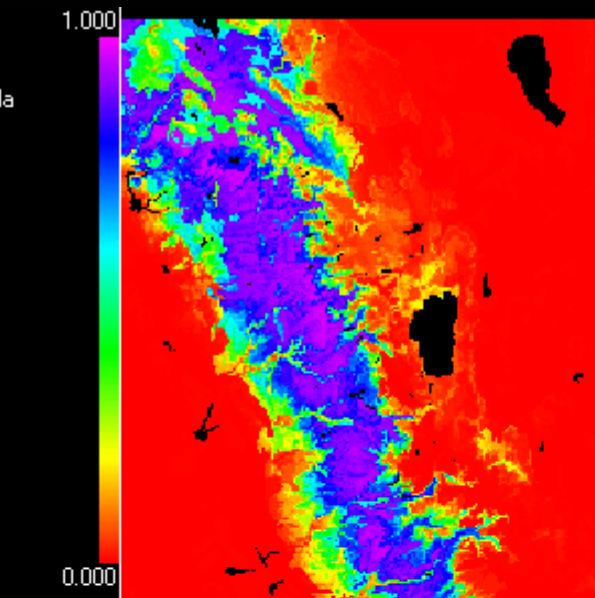
Help

Target species

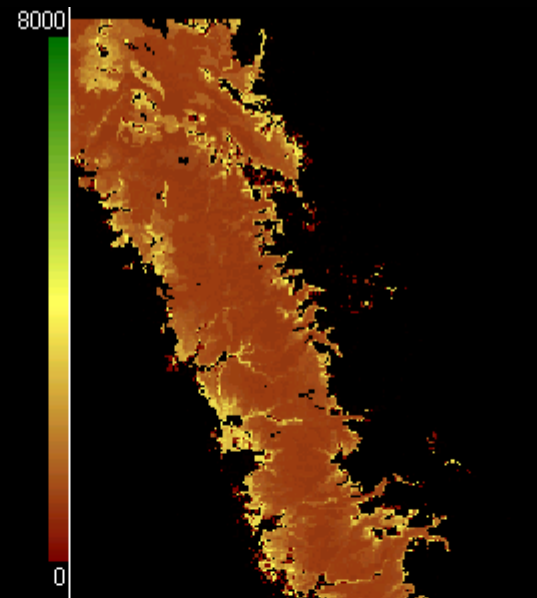
Submodules

BioMove; A Case Study *Pinus lambertiana* 2010

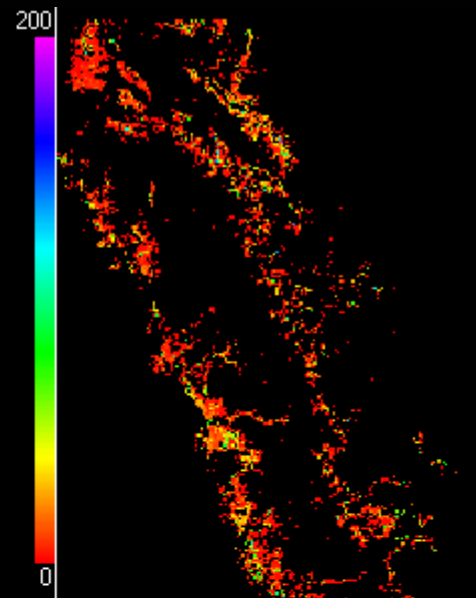
DMOVEII.Envelope
DMOVEII.Mature
DMOVEII.Senescent
DMOVEII.SPP Abunda
DMOVEII.Immature
DMOVEII.Seedlings



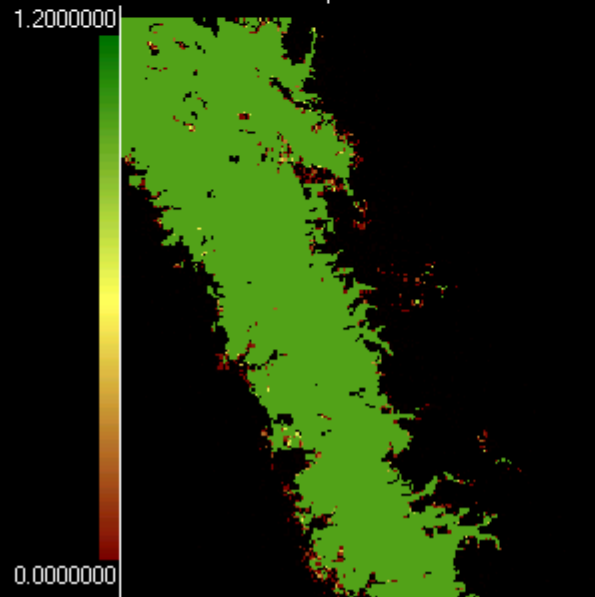
1. BIOMOVEII.Envelope



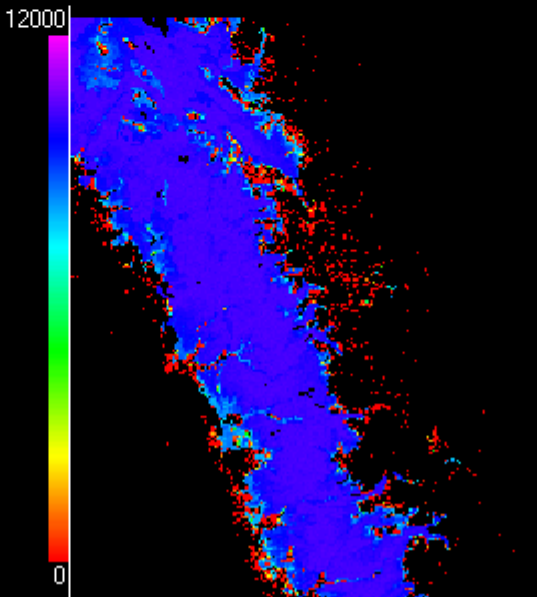
2. BIOMOVEII.Mature



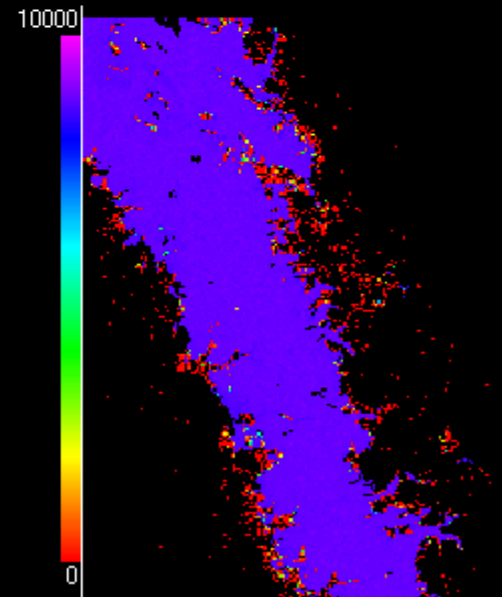
3. BIOMOVEII.Senescent



4. BIOMOVEII.SPP Abundance



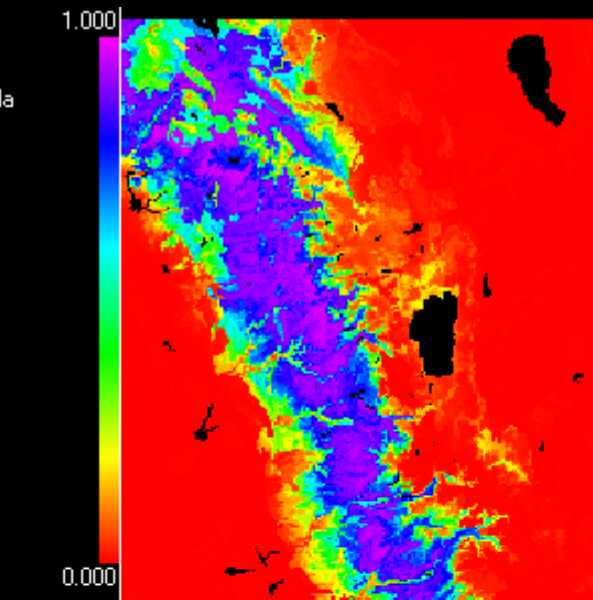
5. BIOMOVEII.Immature



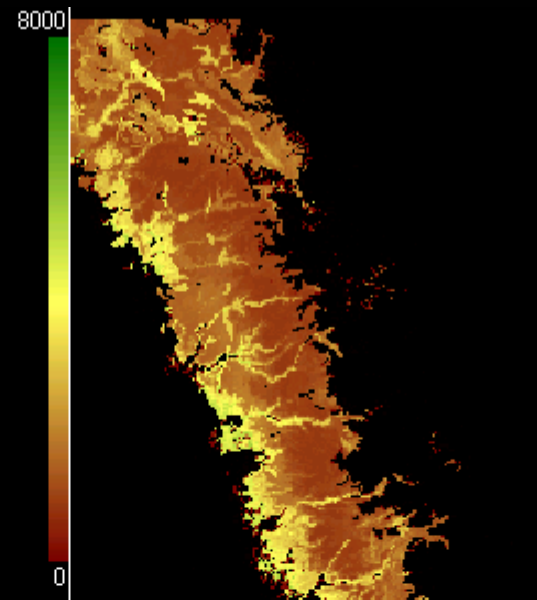
6. BIOMOVEII.Seedlings

BioMove; A Case Study *Pinus lambertiana* 2050

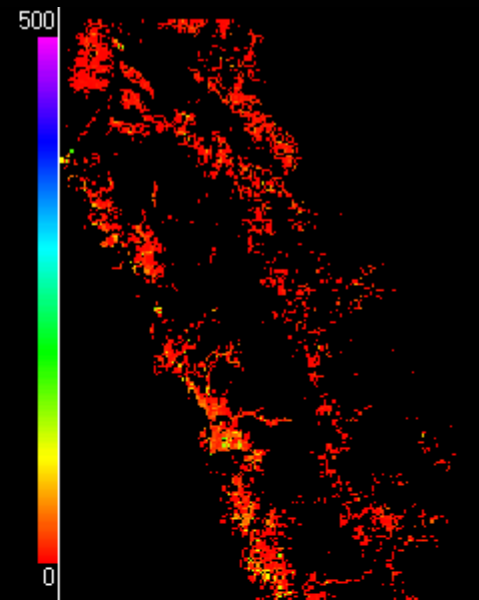
DMOVEII.Envelope
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DMOVEII.SPP Abunda
DMOVEII.Immature
DMOVEII.Seedlings



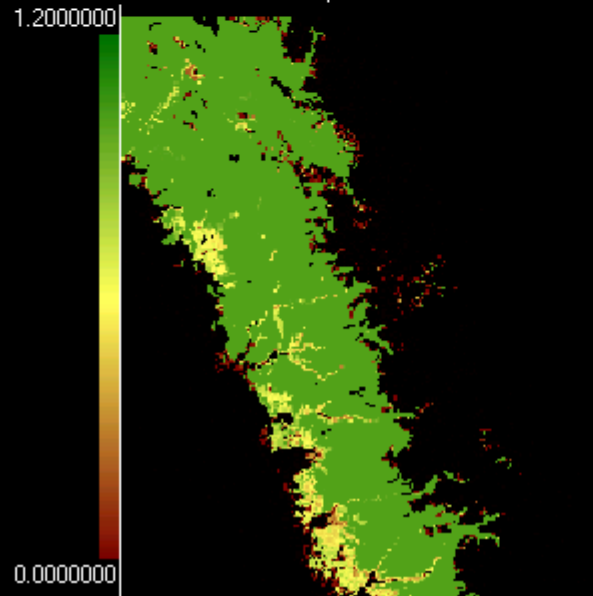
1. BIOMOVEII.Envelope



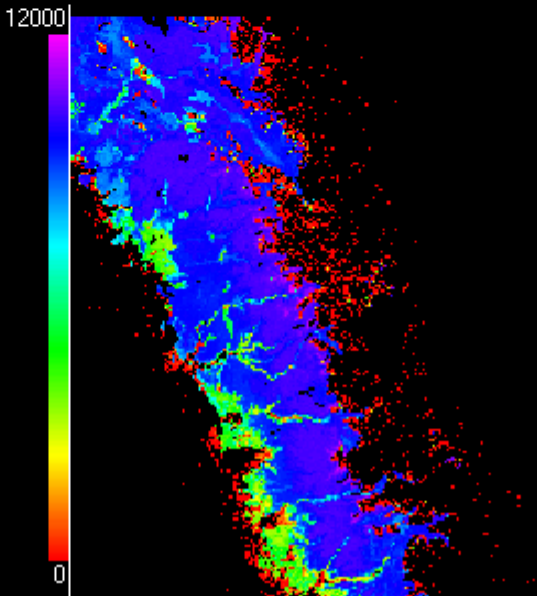
2. BIOMOVEII.Mature



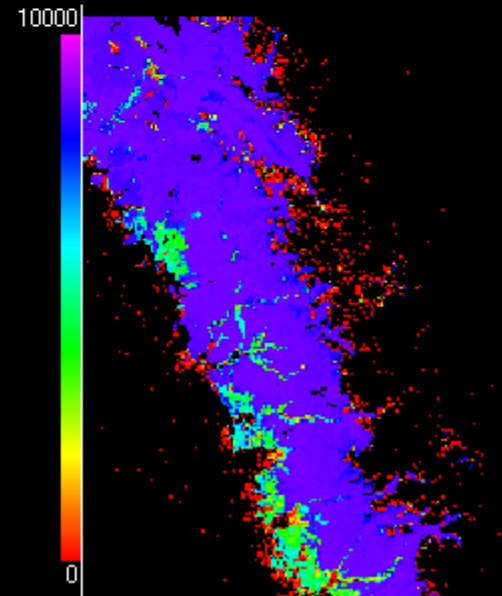
3. BIOMOVEII.Senescent



4. BIOMOVEII.SPP Abundance



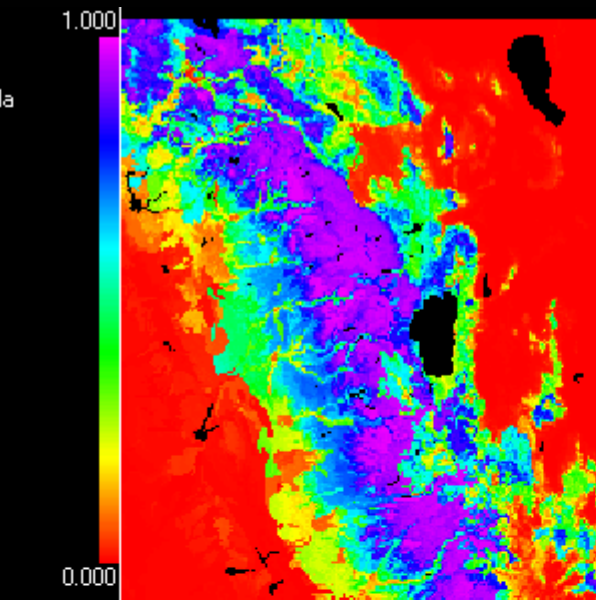
5. BIOMOVEII.Immature



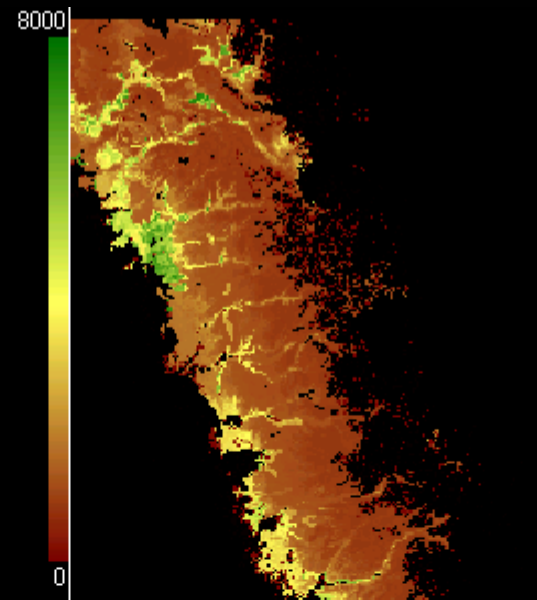
6. BIOMOVEII.Seedlings

BioMove; A Case Study *Pinus lambertiana* 2080

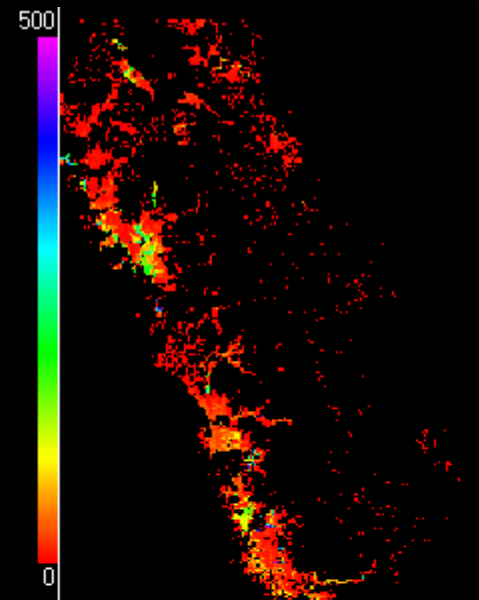
DMOVEII.Envelope
DMOVEII.Mature
DMOVEII.Senescent
DMOVEII.SPP Abunda
DMOVEII.Immature
DMOVEII.Seedlings



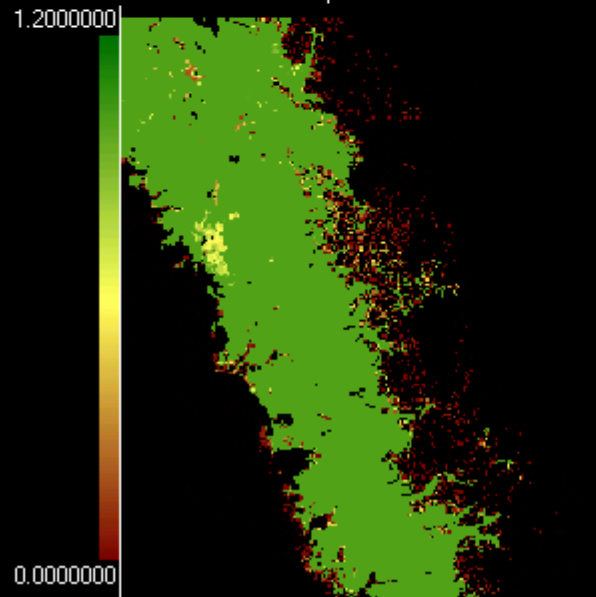
1. BIOMOVEII.Envelope



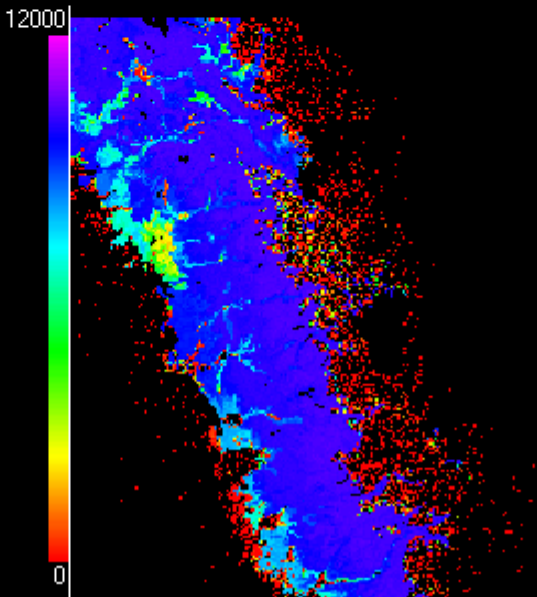
2. BIOMOVEII.Mature



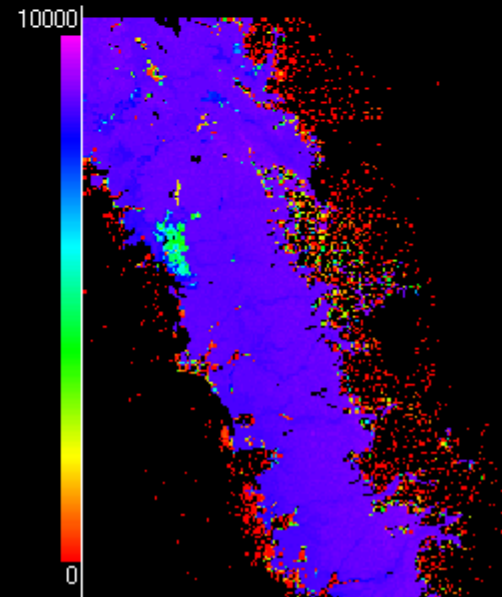
3. BIOMOVEII.Senescent



4. BIOMOVEII.SPP Abundance



5. BIOMOVEII.Immature



6. BIOMOVEII.Seedlings

BioMove; A Case Study

Pinus lambertiana



Spreading upslope in northern region

Loosing some downslope abundance

Stabilization at 2080

Age class patterns

BioMove; A Case Study

Pinus lambertiana



Next Steps:

Land Use-Timber Harvest

Disturbance-Fire

BioMove; A Case Study

Pinus lambertiana

Disturbance: Fire

- CA Dept. of Forestry and Fire Protection, Fire and Resources Assessment Program (FRAP)
- 54 Year Average Fire Frequency
- 4 size classes



Zaca Fire, 3 August 2007

BioMove: a tool for assessing GHG stabilization scenarios

GHG Stabilization Targets:

EU: 2° C global mean temperature change (~450 ppm, IPCC 2007)

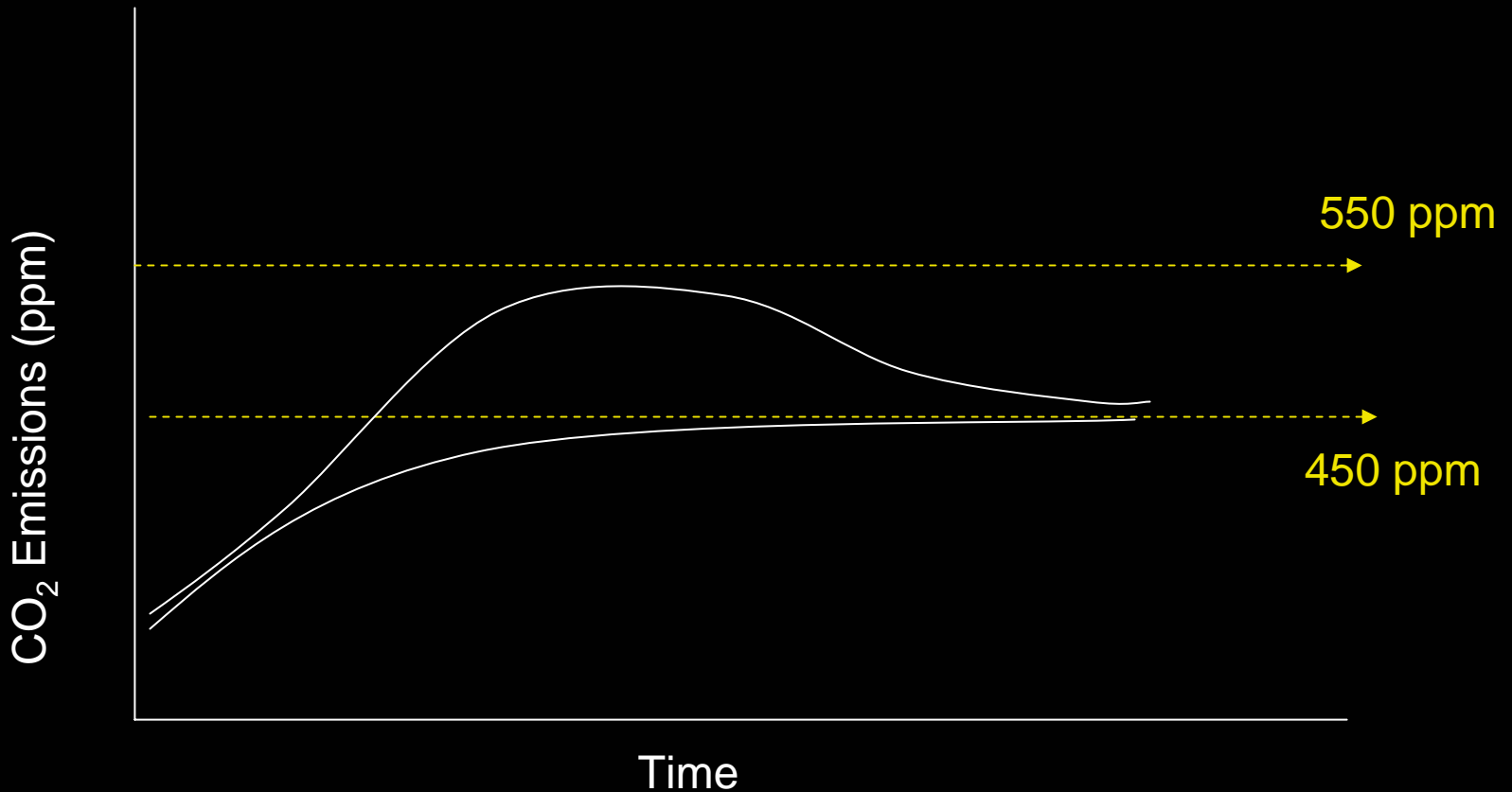
U.S.: USCAP 450-550 ppm CO₂ eq.

Targets set to avoid 'dangerous interference' in the climate system, e.g. avoiding mass extinctions

Current levels 420-480 ppm CO₂ eq.

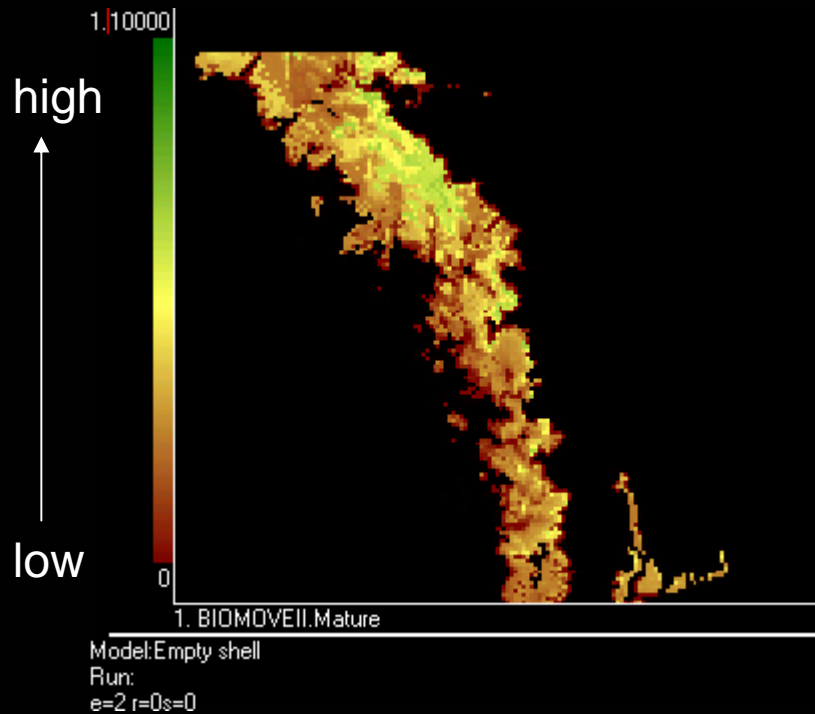
(Pew Center on Global Climate Change, 2007)

BioMove: a tool for assessing GHG stabilization scenarios

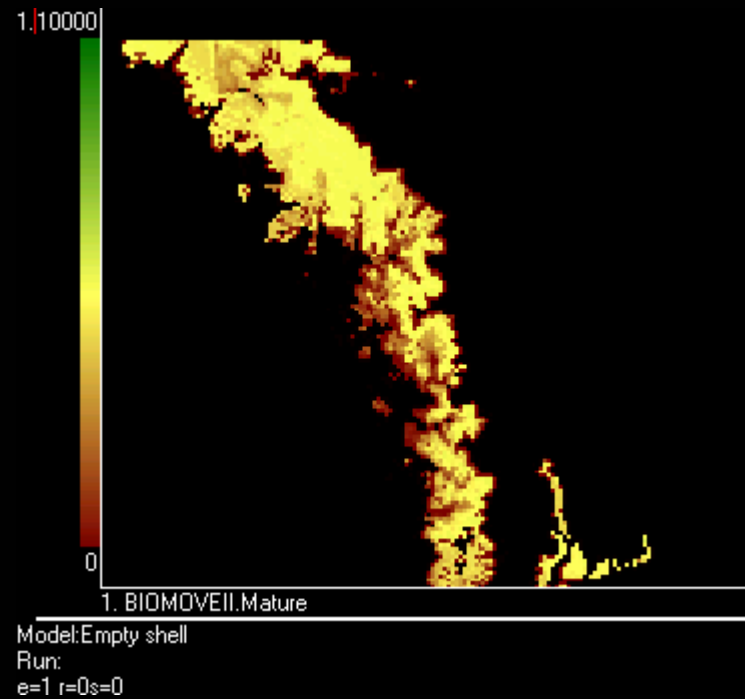


GHG Stabilization Scenarios

Quercus douglasii



450 ppm



overshoot

In summary

- ✓ 314 species library for distribution model outputs
- ✓ Coupled outputs with spatially explicit demographic model
- ✓ Predict climate driven shifts in *P. lambertiana*
- ✓ Predict differences between GHG stabilization projections
- ✓ Continue incorporating competition and disturbance models
- ✓ Implications for management strategies, conservation allocation